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T. R. BAKER ET AL  
FOLDING BOX MACHINE

2,624,248

4 Sheets-Sheet 1

Filed Dec. 28, 1948

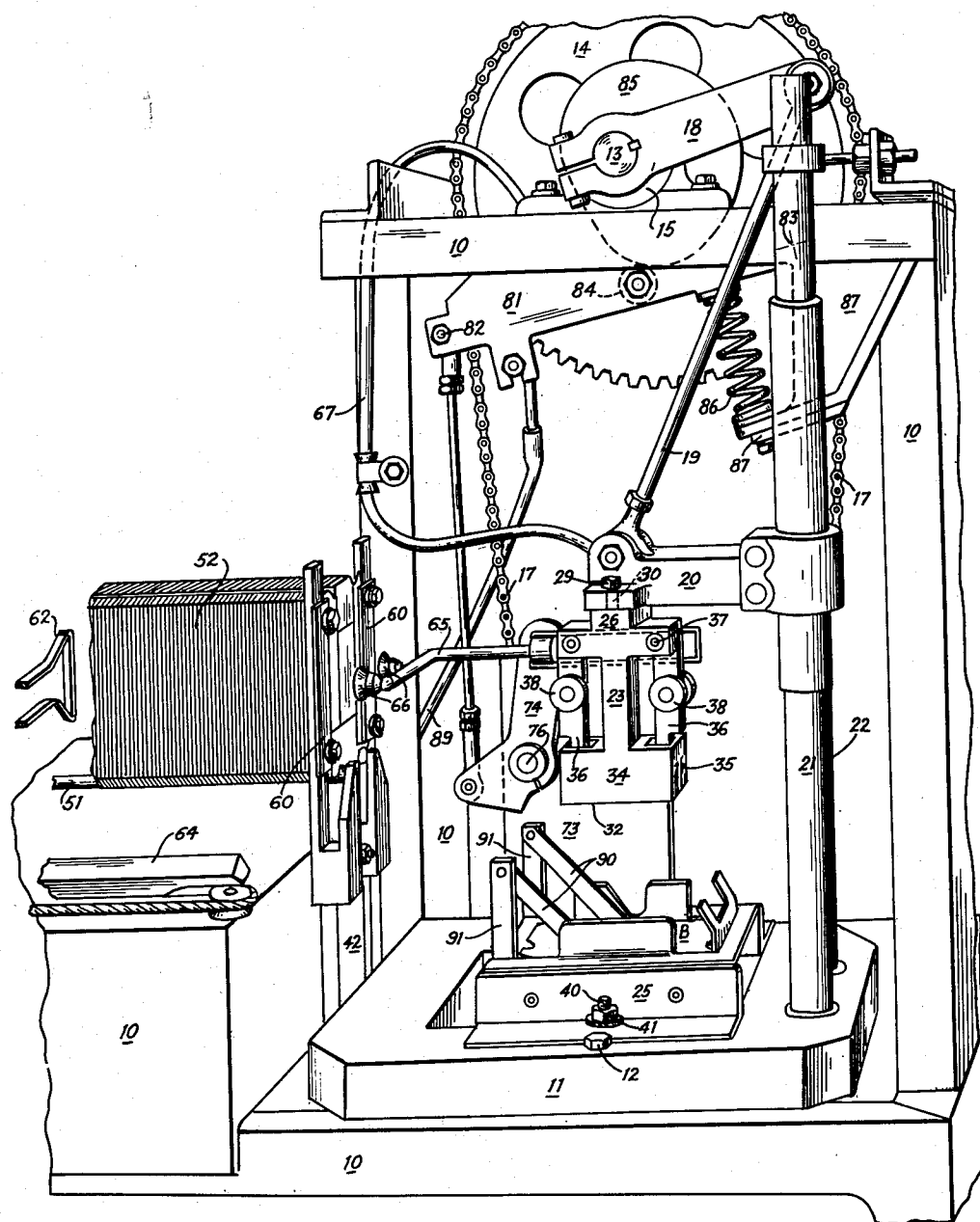


Fig. 1

INVENTORS

Thomas R. Baker and Edward J. Pagendam  
BY

Austin Wilhelm & Carlson  
their ATTORNEYS

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4 Sheets-Sheet 2

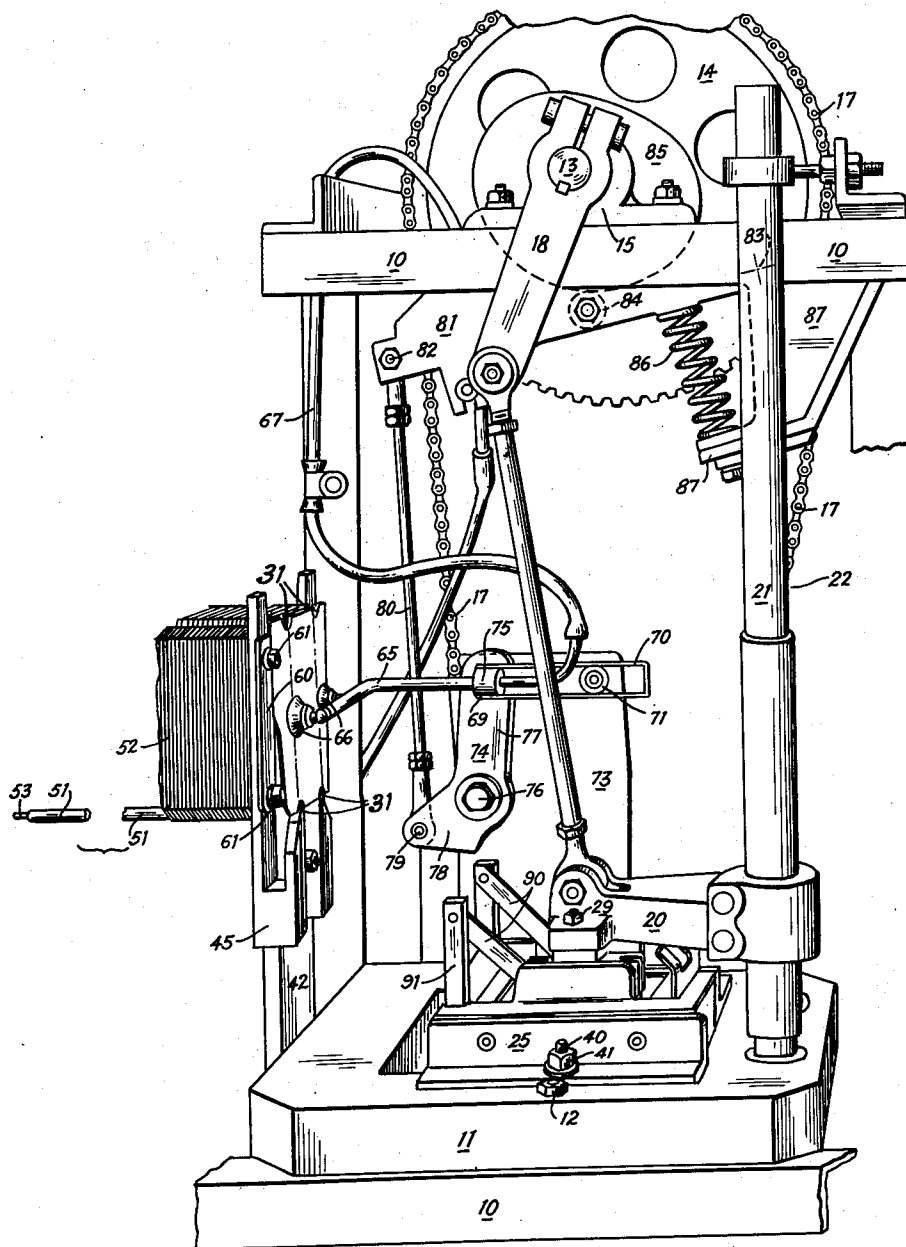


Fig. 2

INVENTORS

Thomas R. Baker and Edward J. Pagendam  
BY

Austin Wilhelm & Carlson  
their ATTORNEYS

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4 Sheets-Sheet 3

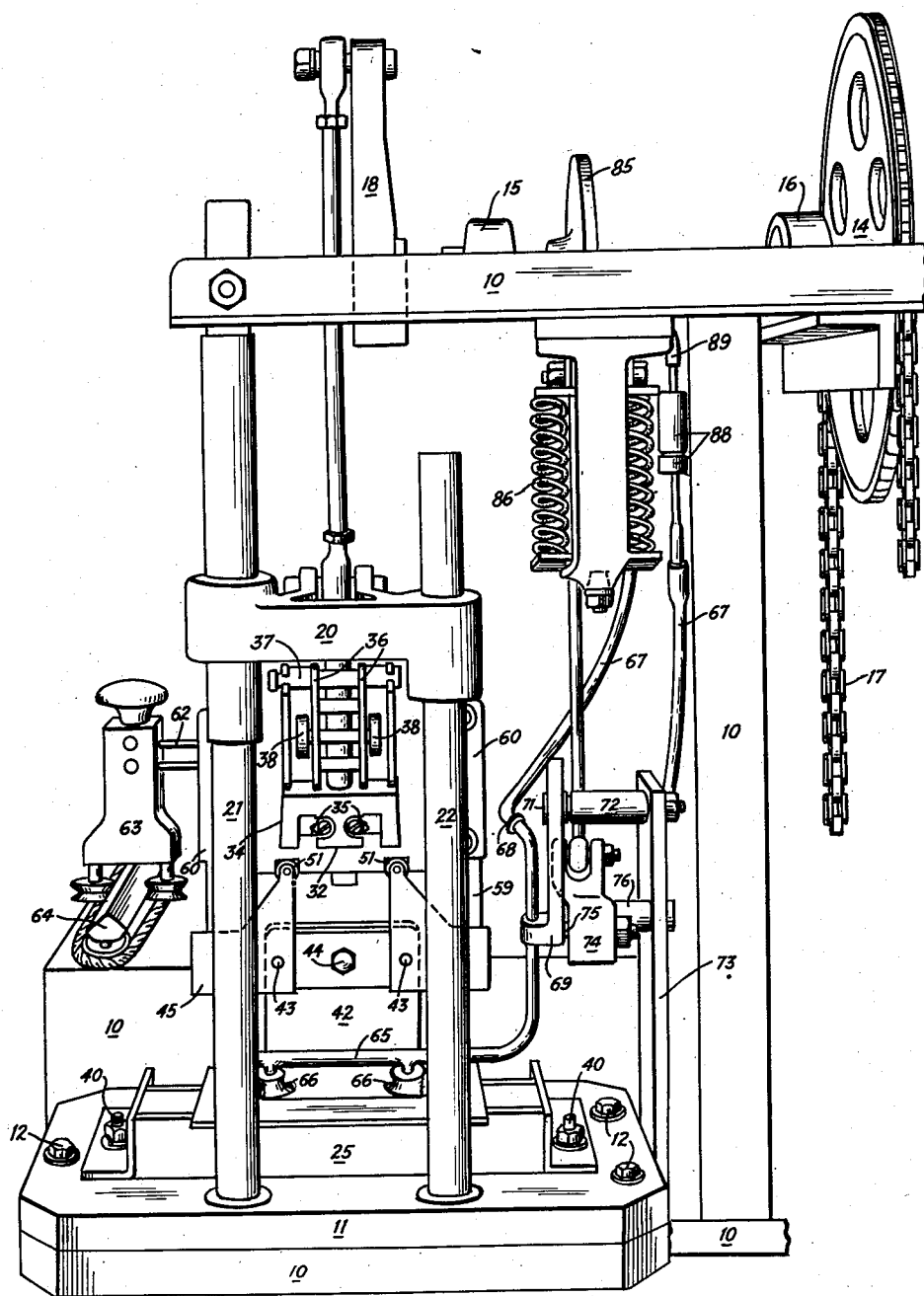


Fig. 3

INVENTORS  
Thomas R. Baker and Edward J. Papadarn  
BY

Arthur Wilhelm Carlson  
their ATTORNEYS

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4 Sheets-Sheet 4

**2,624,248**

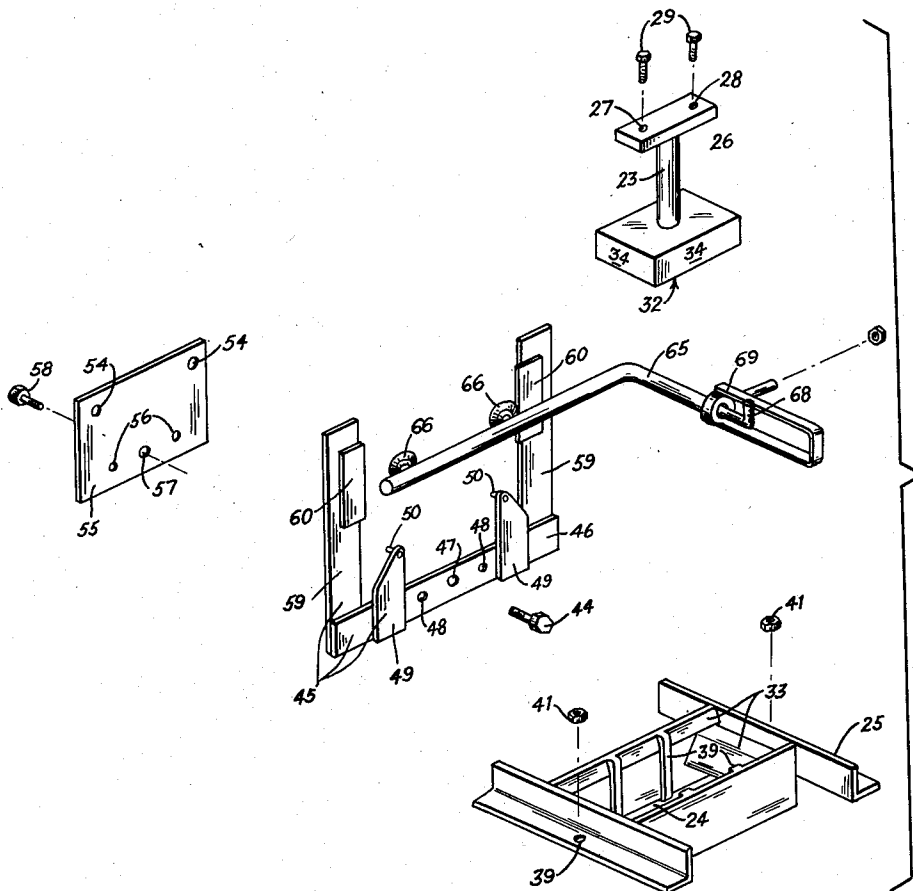


Fig. 4

INVENTORS  
Thomas R. Baker and Edward J. Bagendarm  
BY

Austin Wilhelm & Carlson  
their ATTORNEYS

## UNITED STATES PATENT OFFICE

2,624,248

## FOLDING BOX MACHINE

Thomas R. Baker, Sunnyvale, and Edward J. Pagendam, San Mateo, Calif., assignors to Bemiss-Jason Machine Co., San Francisco, Calif., a partnership

Application December 28, 1948, Serial No. 67,612

4 Claims. (Cl. 93—51)

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This invention relates to improvements in folding box machines of the type in which a flat, or nearly flat blank of foldable sheet material, for example paperboard, is forced through a folding die by a plunger, whereby the blank is folded into hollow box form.

The invention offers particular advantages if applied to those machines of the aforementioned general class which, in addition to folding the blank during its passage through the die, also perform a locking operation on the blank to lock certain blank portions, such as walls, panels, tabs, or flaps together, so that these blank portions thereafter remain in box forming position without extraneous connecting means such as adhesive, staples, rivets, or the like.

However, the invention is not limited in its application to machines for the glueless assembly of folding boxes, but offers many advantages if applied to die and plunger machines for making glued boxes.

In the production of folding boxes it is necessary after completion of a run of boxes of a particular size or style to refit and readjust the machine for a new run of a box of different size or style. Such refitting and readjustment involves the installation of a die and plunger of different size, and in addition an exchange or readjustment of the magazine in which the flat blanks are stored. Generally it is also necessary to change or adjust the feeding mechanism which feeds blanks from the magazine to the die.

It is easily seen that the folding of a box blank at precisely the proper lines not only requires correct adjustment of the plunger with respect to the die, but also a delivery of the blank to the die in precisely that position which leads to the folding of the blank at the intended lines. Accuracy in the delivery and correct placing of the blank is particularly important if the blank is to be gluelessly interlocked, since it is not only necessary to fold the blank at the proper lines, but it is also necessary to bring certain edges or cuts of the blank into accurate registry with other edge or cuts.

Machines for the glueless assembly and interlocking of boxes are capable of production rates which are double and triple the rate of a comparable machine for setting up glued boxes. Production rates of between 150 to 200 boxes per minute are not uncommon for box forming machines of the glueless type. From these illustrative figures it is readily appreciated that extreme accuracy in the position and adjustment of the various elements of the machine is of utmost

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importance, since there is no time for the blank to settle between tapered guides at the mouth of the die, nor is there time for "jogging" the blank in the conventional way by engaging one or several blank edges to push it into correct position.

The adjustment of the several elements of the machine on which the accuracy of placement and the folding of the blank depends is therefore quite critical. In machines of conventional construction the adjustment is a laborious and wasteful procedure.

It is laborious and complicated since it involves minute adjustments of the plunger with respect to the die, of the feeding mechanism with respect to the plunger and die, and finally, an adjustment of the magazine with respect to the feeding mechanisms and to the plunger and die.

It is difficult and wasteful since it is frequently insufficient to adjust and test the machine during trial runs at reduced speed, since at the extremely rapid rates of movement of the machine parts and of the blank mass and inertia of the machine elements and of the blank affect the operation to such an extent as to make trial runs at reduced speed unreliable. Trial runs at normal high production speed, on the other hand, involve considerable spoilage and consequent expense.

The present invention provides improvements which eliminate the necessity of making the above mentioned critical adjustments every time a box machine is set up for a new run requiring a die plunger and magazine of different size. According to the invention the critical elements of the machine are once adjusted by the machine manufacturer, who of course has specially trained and experienced mechanics able to make the necessary adjustments in a fraction of the time which the average shop mechanic of a box manufacturer would require. The elements of the machine which have to be exchanged for production of a different size box are delivered to the box maker in sets or units, which are so arranged that after installation all the elements automatically assume their correct present position. Once the set of elements is installed, the machine is ready for operation at normal speed without any preliminary trial run or further adjustments.

Thus the change-over time is greatly reduced, machine time is saved, waste is eliminated, and the installation of the various elements of the aforementioned set brought within the skill of the ordinary shop mechanic.

The various objections, features, and advantages of this invention will appear more fully from the detailed description which follows ac-

companied by drawings showing, for the purpose of illustration, a preferred embodiment of the invention. The invention also consists in certain new and original features of construction and combination of elements hereinafter set forth and claimed.

Although the characteristic features of this invention which are believed to be novel will be particularly pointed out in the claims appended hereto, the invention itself, its objects and advantages, and the manner in which it may be carried out may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part of it in which:

Figure 1 is a perspective side view of a box machine embodying the present invention, the machine being of the glueless interlocking type shown in a position shortly before the blank feeder picks up a flat blank at the magazine gate;

Figure 2 is a perspective side view of the box machine of Figure 1 at an advanced phase of its operation at the point when a blank is being removed from the magazine by the feeder;

Figure 3 is a perspective end view of the machine at a further advanced phase of its operation at the point when the blank feeder deposits the blank on the folding die; and

Figure 4 is a perspective view in simplified representation of the elements of the set required for changing the box machine for production of a box of different size.

In the following description and in the claims, various details will be identified by specific names for convenience. The names, however, are intended to be as generic in their application as the art will permit. Corresponding reference characters refer to corresponding parts in the several figures of the drawings.

In the drawings accompanying, and forming part of, this specification, certain specific disclosure of the invention is made for the purpose of explanation of broader aspects of the invention, but it is understood that the details may be modified in various respects without departure from the broad principles of the invention and that the invention may be applied to other structures than the ones shown.

The folding box forming machine shown in Figures 1 to 3 produces boxes by folding a blank and interlocking the box corners in a manner to form a rigid self-sustaining box without gluing, stapling, or riveting. Gluelessly interlocked boxes are quite popular because of their low cost, the high rate at which they can be set up and because of the low cost and relatively small size of the machine required for setting them up. The glueless interlock of such boxes generally comprises flaps on the side or end walls which are partially inserted through cuts or apertures in the end or side walls of the box, respectively. The flaps generally engage the walls in edge-to-edge contact, whereby a strong interlock is produced comparable in strength to a glued connection.

Because of the extensive use of gluelessly interlocked boxes a detailed description of a representative blank and box may be dispensed with. It may be stated however that the illustrated machine is particularly equipped to set up and lock boxes of the type disclosed in the patent to Meller No. 2,580,181, dated December 25, 1951.

The machine comprises a supporting framework 10 to which a base 11 is secured by bolts 12. A drive shaft 13 carrying a chain gear 14 is mounted in bearings 15 and 16. The drive shaft 75

is driven through a chain 17 from a motor or other suitable source of power (not shown) and carries a crank 18. A connecting rod 19 connects the crank 18 with a crosshead 20 vertically movable on posts 21 and 22 of the base 11.

The crosshead 20 has a plunger 23 attached to it, movable through the forming and folding aperture 24 of a die 25. The plunger 23 has a head portion 26 with two tapped holes 27 and 28 in it into which bolts 29 fit. The bolts 29 extend through holes 30 in the crosshead 20 with close tolerances so that the plunger assumes a definite position with respect to the crosshead when being secured thereto by the bolts. It has been found 15 that this manner of attachment is sufficiently positive to make the use of additional dowel pins unnecessary. The bottom surface 32 of the plunger 23 is approximately equal in size to the bottom panel of the box to be formed. The bottom surface of the plunger engages a blank placed over the die aperture and forces it through the die while the inner side walls 33 of the die fold the wall panels of the blank towards the outer wall surfaces of the plunger. The plunger is equipped 25 with projectable and retractable elements 35 on the lower ends of levers 36 pivoted in the plunger at 37. The levers 36 carry rollers 38 which cause the levers to swing inwardly when the rollers 38 strike projecting cam surfaces 39 in the die (see Figure 4). This causes the elements 35 to be 30 pulled inwardly to perform a certain locking operation on the blank. A detailed description of these box assembly operations is not required for an understanding of the particular improvements provided by this invention. However, a detailed explanation may be found in the patent to Pagendam No. 2,580,189, dated December 25, 1951. The folding die 25 proper has two holes 39 fitting with close tolerance over bolts 40 in the 40 base. The bolts serve as dowels and cause the die to assume a definite position with respect to the base 11 and also permit the die to be securely fastened to the base by nuts 41. This arrangement causes the die positively to assume a non-adjustable position in the machine in proper 45 relation with respect to the path of the plunger. The described mounting causes the central axis of the plunger to coincide with the center axis of the die, the imaginary vertical line extending through the center of the die aperture.

The base 11 has a rigid gate supporting plate 42 attached to it which near its upper end carries two dowel pins 43 and a central tapped aperture into which a bolt 44 fits. A magazine gate 45 is 55 removably attached to the supporting plate 42. The gate comprises a horizontal plate or bar 46 having a central hole 47 for the bolt 44 and two holes 48 to receive dowel pins 43. Vertical spaced inner arms 49 carry dowel pins 50 at their upper ends over which blank supporting rods 51 fit. The rods, in turn, fit cut-out or recessed portions 31 of a stack 52 of blanks B and align the blanks with respect to the magazine gate 45. The far ends of the rods 51 also carry dowel pins 53 fitting into holes 54 of a back plate 55. The back plate 55 supports the far end of the stack in a similar way as the magazine gate 45. As shown in Figure 4 the back plate has further holes 56 for 60 dowel pins and a central hole 57 through which a securing bolt 58 may be inserted to hold the back plate 55 in place relatively to the framework 10 of the machine.

Vertical outer arms 59 of the magazine gate carry blank retaining plates 60. The blank retaining plates are secured to the arms 59 by bolts

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61 and are spaced from each other slightly less than the width of the blanks B. Thus the retaining plates 60 prevent the blanks in the magazine from falling out under the pressure of a feeder arm 62 urging the blanks towards the gate. The feeder arm 62 is supported by a carriage 63 which runs on a prismatic track 64 and bears against the rearmost blank to feed the entire stack of blanks towards the magazine gate.

The spacing of the retaining plates 60 permits removal of the frontmost blank by grasping the blank intermediate the retaining plates and pulling it away from the stack of blanks in the magazine. This causes the frontmost blank to flex slightly and to snap with its side edges past the edges of the retaining plates 60.

The blank feeder mechanism comprises a feeder arm 65 carrying a pair of suction cups 66. The feeder arm 65 is hollow and serves as a suction duct to apply at proper intervals a partial vacuum to the suction cups. The feeder arm has a flexible duct 67 attached to its end at 68. The arm is rigidly mounted on a bracket 69 having an elongated guide-way 70 engaging the cylindrical outer surface of a ball bearing 71. The ball bearing 71 is mounted on a stud 72 on a supporting plate or post 73 which, similar to the gate supporting plate 42, is rigidly and permanently attached to the base 11.

The bracket 69 of the feeder arm 65 is pivotally connected to one arm of a bell crank lever 74 at 75. The bell crank lever 74 is pivotally mounted on the supporting plate 73 at 76. It has two arms, the one arm 77 being represented by the distance between the pivotal axes 75 and 76, the other arm 78 being represented by the distance between the pivotal axis 76 and the axis of a pin 79 at which one end of a connecting rod 80 is attached to the bell crank lever.

The other end of the connecting rod 80 is pivotally connected to a rocking lever 81 at 82. The rocking lever 81 is pivoted in the framework 10 of the machine about an axis 83 and carries a cam follower 84 urged against the periphery of a cam 85 on the drive shaft 13. The rocking lever 81 is under the action of helical compressed springs 86 bearing with its one end against the rocking lever proper and with the other end against a bracket 87 secured to the framework 10.

The cam 85 is fast on the drive shaft 13 and causes the rocking lever 81 to oscillate about its axis. This, in turn, causes the bell crank lever 74 to oscillate about its pivot 76 to move the feeder arm 65 in a manner presently to be described.

Beginning with the position of the elements of the machine, as shown in Figure 1, a blank B rests on the folding die 25, and the plunger 23 is on its downward stroke driven by the crank 18 moving in a clockwise sense. The rocking lever 81 is nearing its lowermost position as the cam follower 84 is climbing onto portions of the cam of progressively increasing radius. The feeder arm 65 is in front of the magazine gate and the suction cups 66 are only a short distance from the frontmost blank, moving towards the blank in order to grip it. As the follower 84 of the rocking arm 81 continues to climb with respect to the cam the rocking lever is depressed further causing the bell crank lever 74 to turn counterclockwise until the suction cups 66 make contact with the frontmost blank of the stack 52.

It will be observed that at this point the

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motion of the feeder mechanism is relatively slow due to the very gradual change in curvature of the cam 85 at the point of contact with the follower 84. In distinction, the movement of the plunger 23 is relatively rapid as the plunger approaches the die 25.

Referring now to Figure 2 showing the machine at a phase of operation advanced approximately 120 degrees, in terms of crank angle, it will be seen that the plunger has forced the blank previously resting on the die entirely through the die, performing the folding operation on the blank, and has begun to return towards its upper dead center position.

The cam follower 84 has just moved over the highest portion of the cam thereby causing the suction cups 66 to make contact with the frontmost blank. As the cam follower continues to move onto cam portions of progressively shorter radius, the rocking lever 81 moves upwardly under the action of the spring 86 and the bell crank lever 74 turns in a clockwise sense thereby moving the suction cups to the right. This causes the frontmost blank to flex and to snap past the edges of the retaining plates 60. Figure 2 illustrates the instant at which the right side edge has cleared the retaining plate, whereas the upper portion of the left side edge of the blank is still in engagement with the respective retaining plate.

The suction cups with a blank attached to them now swing towards the die as the pivotal axis 75 of the feeder bracket 69 moves about the pivotal axis 76 of the bell crank lever. During the latter phase of movement the rocking lever 81 approaches its uppermost position as the cam follower 84 gradually moves onto the portion of the cam having the shortest radial distance from the drive shaft axis.

Simultaneously the crank 18 which operates the plunger 23 moves towards its upper dead center position causing the plunger to clear the die so that the feeder can deposit the blank on the upper die surface underneath the plunger.

Figure 3 shows the machine with the crank 18 at the upper dead center position. At this phase the feeder arm 65 has reached a vertical position ready to deposit the blank on the die. The point of release is controlled by a valve 88 in the duct 67 which at the proper moment shuts off the duct from the vacuum line 89 and vents it to the atmosphere. The blank now drops onto the receiving surface of the die.

Removal of the blank from the suction cups is assisted by two flat strippers 90 of flat spring bronze, or spring steel mounted on posts 91 of the die. During the last portion of the feeding movement the feeder moves the blank past the lower ends of the strippers 90 which then flex slightly inwardly to engage the upper surface of the blank and retain it on the die. The strippers thus prevent the blank from being disturbed as the suction cups return empty to the magazine.

It is quite evident that the proper functioning of the machine depends on an accurate adjustment of the plunger with respect to the die and also on the adjustment of the feeding mechanism with respect to the die and to the magazine. The proper relationship between these elements must therefore be established every time the machine is changed to produce a box of a different size.

The invention simplifies the changeover from one box size to another and eliminates the necessity of making individual adjustments by the

peculiar design construction which reduces the entire changeover operation to a simple exchange of a few elements which the manufacturer of the machine furnishes the box maker in sets ready for installation.

One set of elements is shown in Figure 4. The set includes a die 25 and a plunger 23 to fit it. It further includes a magazine gate 45 and a feeder arm 65 with properly spaced suction cups.

As previously described, the plunger assumed its correct position with respect to the crosshead 20 by attaching it to the crosshead by bolts 29. The die 25 is properly centered by placing it over the bolts 40 thus bringing the axis of the die into proper relationship with respect to the axis of the crosshead 20 and of the plunger 23.

The magazine has a substantially horizontal central axis which, as quite apparent from Figure 3, lies in the same vertical plane as the central axis of the die and of the plunger. The magazine is automatically aligned by attaching the magazine gate 45 to its supporting plate 42. The dowel pins 43 prevent any misalignment. The stack of blanks assumes its proper position in the magazine by reason of the rods 51 fitting into diecut recessed portions of the blanks.

The feeder mechanism also assumes its proper position by reason of being attached to the bell crank lever 74. It will be remembered in this connection that the bell crank lever is pivoted to the supporting plate 73 and that the ball bearing 71 engaging the guide way 70 is also mounted on this plate.

It is, therefore, evident that all the elements of the machine which control the movement and the proper placing of the blank onto the die are automatically brought into proper relative position by simply attaching these elements by a few nuts or bolts.

The time consuming and wasteful adjusting of the machine is, therefore, eliminated and the machine is ready for operation at full speed as soon as a new die plunger, feeder, and magazine assembly is installed.

The invention thus simplifies the change of the machine from one box blank to another, saves machine time, and eliminates waste. It furthermore, makes the service of highly skilled specialists familiar with the adjustment of these machines dispensable and enables the average shop mechanic to perform all the necessary operations without danger of maladjustment.

What is claimed is:

1. A machine for folding into hollow box form flat blanks of foldable sheet material, the machine comprising, a folding die, a plunger movable through said die, a magazine for blanks having a front gate through which the frontmost blank passes, means for supporting a stack of blanks in a predetermined positional relation to said gate, and a suction gripper for removing a blank from the magazine at the gate and depositing it on the die, the suction gripper being mounted for pivotal movement about an axis normal to both the magazine axis and the die axis, the machine being characterized by, and further including, a base having a top surface and an aperture through which said plunger is movable; first means on said base and on said folding die, respectively, for removably securing said die on said top surface in a predetermined fixed position; and upstanding side bracket on said base; a pivotal bearing member on said side bracket for said gripper, said pivotal bear-

ing member being fixed on said bracket in a predetermined fixed position with relation to said first means; an upstanding front bracket on said base for said gate; and second means on said front bracket and on said gate for removably securing said gate on said front bracket in a predetermined fixed position with relation to said first means and said bearing member whereby the machine may be changed from one box size to another by an exchange of gates and dies without requiring adjustment of gate and die with respect to the suction gripper.

2. A machine for holding into hollow box form flat blanks of foldable sheet material, the machine comprising, a folding die, a plunger movable through said die, a magazine for blanks having a front gate through which the frontmost blank passes, means for supporting a stack of blanks in a predetermined positional relation to said gate, and a suction gripper for removing a blank from the magazine at the gate and depositing it on the die, the suction gripper being mounted for pivotal movement about an axis normal to both the magazine and the die axis, the machine being characterized by, and further including, a base having a top surface and an aperture through which said plunger is movable; first means on said base and on said folding die, respectively, for removably securing said die on said top surface in a predetermined fixed position; an upstanding side bracket on said base; a pivotal bearing member on said side bracket for said gripper, said pivotal bearing member being fixed on said bracket in a predetermined fixed position with relation to said first means; an upstanding front bracket on said base for said gate; a second means on said front bracket and on said gate for removably securing said gate on said front bracket in a predetermined fixed position with relation to said first means and to said bearing member; an upstanding track element on said base; a crosshead slidable on said track element; and third means on said crosshead and on said plunger, respectively, for removably securing said plunger to said crosshead in a predetermined fixed relation with regard to said first means, said second means and said bearing member, whereby the machine may be changed for one box size to another by an exchange of gates and dies without, however, requiring adjustment of a replaced gate and die with respect to the suction gripper and the path of the plunger.

3. A machine for folding into hollow box form flat blanks of foldable sheet material, the machine comprising, a folding die, a plunger movable through said die, a magazine for blanks having a front gate through which the frontmost blank passes, means for supporting a stack of blanks in a predetermined positional relation to said gate, and a suction gripper for removing a blank from the magazine at the gate and depositing it on the die, the suction gripper being mounted for pivotal movement about an axis normal to both the magazine and the die axis, the machine being characterized by, and further including, a base having a top surface and an aperture through which said plunger is movable; first means on said base and on said folding die, respectively, for removably securing said die on said top surface in a predetermined fixed position; an upstanding side bracket on said base; a pivotal bearing member on said side bracket for said gripper, said pivotal bearing member being fixed on said bracket in a predetermined fixed

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position with relation to said first means; an upstanding front bracket on said base for said gate; and second means on said front bracket and on said gate for removably securing said gate on said front bracket in a predetermined fixed position with relation to said first means and to said bearing member; at least one standard mounted on said base normal to said surface; a crosshead slidable on said standard; and third means on said crosshead and on said plunger, respectively, for removably securing said plunger to said crosshead in a predetermined fixed relation with regard to said first means, said second means and said bearing member, whereby the machine may be changed from one box size to another by an exchange of gates, dies and plungers without, however, requiring adjustment of a replaced gate and die with respect to the suction gripper and the path of the plunger.

4. A machine for folding into hollow box form flat blanks of foldable sheet material, the machine comprising, a folding die, a plunger movable through said die, a magazine for blanks having a front gate through which the frontmost blank passes, means for supporting a stack of blanks in a predetermined positional relation to said gate, and a suction gripper for removing a blank from the magazine at the gate and depositing it on the die, the suction gripper being mounted for pivotal movement about an axis normal to both the magazine and the die axis, the machine being characterized by, and including, a base having a top surface and an aperture through which said plunger is movable; first means on said base and on said folding die, respectively, for removably securing said die on said top surface in a predetermined fixed position; an upstanding side bracket on said base; a pivotal bearing member on said side bracket for

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said gripper, said pivotal bearing member being fixed on said bracket in a predetermined fixed position with relation to said first means; an upstanding front bracket on said base for said gate; and second means on said front bracket and on said gate for removably securing said gate on said front bracket in a predetermined fixed position with relation to said first means and to said bearing member; at least one standard mounted on said base normal to said surface; a crosshead slidable on said standard; third means on said crosshead and on said plunger, respectively, for removably securing said plunger to said crosshead in a predetermined fixed relation with regard to said first means, said second means and said bearing member; a bell crank lever mounted on said side bracket on a pivotal axis parallel to, and spaced from, said pivotal bearing member, one arm of the bell crank lever carrying said gripper, said gripper also pivotally engaging said bearing member with freedom to slide relatively thereto.

THOMAS R. BAKER.  
EDWARD J. PAGENDARM.

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